

Determination of Secondary School 4th Grade Students' Mental Models of The Astronomer

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Article Info

Article history:

Received Feb 1, 2018

Revised May 12, 2018

Accepted May 27, 2018

Keyword:

Astronomer

Astronomy

Mental model

Model

Secondary school students

ABSTRACT

Teaching astronomy to young generations is of great importance because astronomy education helps us to better understand the world we are living in and to find answers to our questions. In this regard, the current study aimed to determine the secondary school 4th grade students' mental models of the astronomer. The current research is designed as a descriptive study employing the special case study method. The study was conducted in a city located in the western part of Turkey. The study group is comprised of a total of 77 secondary school 4th grade students attending a state school. In line with the purpose of the study, a data collection tool consisted of 2 open-ended questions was developed. In light of the findings of the study, it can be argued that the mental models possessed by the students about the astronomer are the scientific model, the astronaut model and the celestial bodies model

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1. INTRODUCTION

Economic superiority in the world is believed to coincide with the level of development. In order to enhance their economies and level of development, countries allocate a great importance to the field of science so that they can maintain their competitiveness. Innovations and advancements in the field of science should be followed for Turkey to achieve greater development and to place its economy onto the top positions in the world. Determination of the problems experienced by students in relation to science education is believed to affect the future direction of science education which is very important for many countries. Despite the fact that science is a part of everyday life, some science subjects and concepts are abstract, leading to learning difficulties in students. One of the important subjects of science education [1], astronomy has an important place in science education due to abundance of abstract concepts it includes, its content and interdisciplinary characteristics [2]. According to Tascan [3], astronomy is a science, which allows individuals to better understand the world and the universe. It is important to know astronomy in order to be able to catch up with the developments in the world. After the launch of the first satellite called "Sputnik" by Russia in 1957, countries such as America incorporated the subjects of astronomy into their curricula [4]. In China, Hungary, England, Portugal and Brazil, topics related to astronomy and space science are taught either as an independent course, or as integrated with geography or physics, starting from primary school [5]. Although the importance of astronomy was recognized in 1990s in European countries, it has been recently gaining greater importance in Turkey [4]. While the course of astronomy was given as an independent course up to 1937 in Turkey, it has been offered as an elective course since 1974. With the decision of the Board of Education of 1992, the general objectives of the course of Astronomy and Space Science were determined and the relationship between Science and Astronomy and Space Science topics was

clearly defined [6]. Astronomy topics, which have also been included in science curricula within the science course, have been taught in a spiral manner in the 2007, 2008a, 2008b, 2009, 2013 and 2017 science curricula. In the 2017 curriculum, astronomy topics have been relocated in the program and have been shifted from fall term to spring term, into preliminary units.

When the literature is reviewed, it is seen that there is a great deal of research focusing on astronomy education [7-18]. While some of these studies looked at the conceptual change processes [9, 19], some others revealed mental models [20, 12, 1].

It is important to know alternative concepts developed by students in astronomy education. As known, it is quite difficult to correct a misconception later. The point that should be kept in mind is that they are very resistant to change, no matter how intense work is done to change alternative concepts [21]. When the literature was reviewed, it was determined that there was no study to determine students' mental models of astronomy. Because of the similarity of the writing of astronomy, astrology and astronomer, these three concepts are often interchangeably used and confused. A study by Arikurt, Durukan and Şahin [22] found that students use the concepts of astronomy and astronomer interchangeably. The literature review showed that there is no study to reveal mental models related to the concept of astronomer. In the 2013 curriculum, it is stated that students recognize the difference between astronomer and astronaut within the context of the middle school 3rd grade "Solar System and Beyond" unit. On the other hand, some of the objectives stated in the 2017 curriculum within the context of the unit "Space Research" is that "Students can make inferences about the role of the telescope in the development of astronomy" and "learn something about the selection of the places where observatories are built and about the characteristics of such places" and "learn about the contributions of western astronomers and Turkish-Islamic astronomers". Within the new curriculum, these objectives have become more focused on the connections with the everyday life and the contributions of astronomers to make students gain a better understanding of the nature of science. Therefore, it is important to reveal the concept of astronomy that students have formed in their minds, to show how and in what way they have structured this concept, and to provide an idea of how to learn this concept. In addition, teachers need to be aware of alternative ideas of their students for effective teaching regardless of their source [23]. It is believed that the results obtained from the current study will benefit the teachers working in this field and will help in designing better teaching environments.

2. RESEARCH METHOD

The current study employed the special case study design, one of the qualitative research approaches. The case study research is a qualitative approach used by the researcher to collect in-depth and detailed data about the real life, an up-to-date limited system or multiple limited systems within a certain time period by using various sources of information [24]. In the current study, it is aimed to determine students' mental models of the concept of astronomer without disturbing the natural conditions. The special case study design offers the opportunity to obtain in-depth information in a short period of time in line with the purpose of the study [25]. The most important advantage of the special case study is that it enables the researcher to concentrate on the subject or case. The current study was conducted in the spring term of 2016-2017 school year and the sampling of it is comprised of 4th grade students attending a state secondary school in a city located in the western part of Turkey. A total of 77 students participated in the study. A data collection tool consisted of two open-ended questions developed by the researchers to elicit the students' mental models of the astronomer was used. The data collection tool was submitted to the scrutiny of field experts to check its comprehensibility, applicability and the extent to which it serves the purpose of the study. In light of the feedbacks given by the experts, required corrections were made on the data collection tool. In the second stage, a piloting of the data collection tool was performed on a different sample and no problem was found to have been experienced as a result of the piloting. In order to determine the reliability of the test, the results obtained from 6 students were coded by two researchers and consistency coefficient was calculated. The inter-rater consistency was found to be 86%. Moreover, all the findings of the study are directly presented without any interpretation to increase the internal reliability of the study. The open-ended questions in the data collection tool are:

1. What does the word "Astronomer" mean to you? Explain briefly.
2. Please, draw the picture that occurs in your mind when you hear the word "Astronomer".

In the analysis of the collected data, two of the qualitative analysis methods; descriptive analysis and content analysis, were employed. Within the context of the current study, the students were given codes (S1, S2, S3...S77). In this coding, S stands for student and the number indicates the order of the student.

3. RESULTS AND ANALYSIS

By analyzing the secondary school 4th grade students' responses to the two open-ended questions about the astronomer together, 3 different mental models were elicited as shown in Table 1. These mental models can be addressed in two categories. First one is scientific mental models and the second one is synthesis mental models (astronaut model, celestial bodies model). Of these models, while the scientific model and the astronaut model are the most frequently used ones, the celestial bodies model is the least frequently used one. When the 2013 science curriculum is examined, it is seen that the units "The Solar System and Beyond; The World and Universe" are taught in the third grade. Through these units, what is aimed is that students are introduced to celestial bodies, understand the concept of system, understand the role of the telescope in astronomy and acquire knowledge and skills about space exploration. In this regard, there are 9 objectives and one of them is to make students recognize the difference between astronomer and astronaut. As can be seen in Table 1, 36 students out of 77 students have the scientific mental model.

Table 1. Secondary School 4th Grade Students' Mental Models of Astronomer

Mental models	f	%	
Scientific model	36	46.8	
Synthesis models	Astronaut model	26	33.8
	Celestial bodies model	13	16.9
Drawings without any category	2	2.6	
Total	77	100	

The students having the scientific mental model are knowledgeable about the definition and characteristics of the concept of astronomer and reflected this in both their verbal explanations and drawings. When the drawings of the students included in this category are examined, it is seen that the students are of the opinion that the astronomer explores the movements and structures of celestial bodies by using the telescope and technological devices (e.g. computer). Moreover, some students pointed out that the astronomer conducts his/her observations in observatories. Some examples of students' scientific mental model are presented in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6.



Figure 1. Drawing and explanation belonging to S73

Astronomers are people working in the field of astronomy exploring the sky and space. The only institution of astronomy I know is NASA.

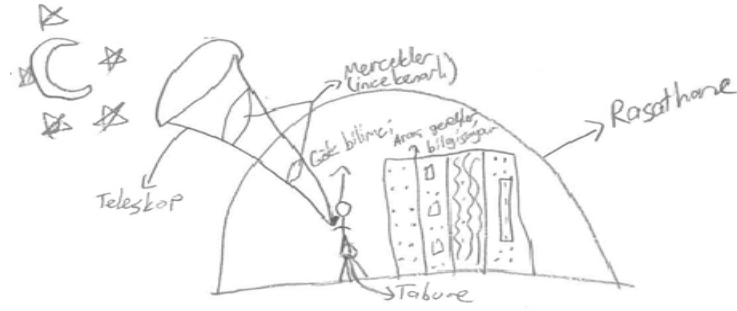


Figure 2. Drawing and explanation belonging to S51

The astronomer is the scientist exploring the space beyond the atmosphere of the world by means of technological devices.

It was also found that 26 students out of 77 students have the astronaut mental model. In all the drawings evaluated in this category, students depicted a scientist in astronaut clothes conducting research on a kind of heavenly body. Some examples of the astronaut mental model found to be possessed by students are given below.



Figure 3. Drawing and explanation belonging to S20

This is one of the professions I want to have. It refers to the space. This is the repercussion of man's dream of traveling to space.



Figure 4. Drawing and explanation belonging to S21

People traveling to space to conduct various research and wearing odd costumes.

It was determined that 13 students out of 77 students have the celestial bodies mental model. In the drawings evaluated in this category, students did not draw any human figure, they only drew different heavenly bodies. In almost all of these drawings, there is the Sun, Jupiter, Saturn, World and stars. Some examples of the celestial bodies' mental model found to be possessed by students are given below.



Figure 5. Drawing and explanation belonging to S16
Space, sky, start, moon.



Figure 6. Drawing and explanation belonging to S17
A person who explores the heavenly bodies in the space

The findings of the study revealed that while 36 out of 77 students have the scientific mental model, 39 have the synthesis mental model. In their explanations, the students associate the concept of astronomer with different concepts aside from “profession”. The other concepts with which they associate the concept of astronomer most frequently are astronomy (13) and astronaut (26). Thus, it can be contended that the students confuse the concepts of astronomer, astronomy and astronaut. This finding concurs with the findings reported by Arı Kurt et. [22]. Of the 77 students participating in the study, 26 drew an astronaut in their drawings. In the astronaut mental model, students depicted a scientist in astronaut clothes conducting research in the space. In the 2013 science curriculum, the unit “The Solar System and Beyond” is the last unit. Thus, this unit may not have been studied efficiently and as a result the students may have used their prior knowledge received from extracurricular sources to explain the subjects. Some amendments were made on the 2017 science curriculum and now this unit is studied as the first unit of the fall term.

4. CONCLUSION

Since prehistoric times, the sky has attracted the attention of people from cultures in all over the world. From the examination of the history of science, it is known that the civilizations that are located in the west and the east have contributed to the field of astronomy. Turks are not exception to this; the contributions of Turks either being theoretical and practical to astronomy are remarkable. For example, Turks have established observatories quite important in terms of science and astronomy history and they have trained prominent astronomers in these observatories. However, as the work conducted in the field of astronomy and

space technology is highly expensive, not enough importance is attached to this field in our country. On the other hand, a study conducted by TÜBİTAK revealed that the issues most attracting the attention of young people aged at 15-24 in Turkey are "Internet" and "astronomy". Thus, astronomy should be supported more. Yet, it should not be forgotten that the cognitive structures of students are formed at early ages; therefore, more importance should be attached to astronomy education in elementary and secondary schools. It should be noted that astronomy is of great importance for the development of basic sciences and raising the social awareness.

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